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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/660,573	09/12/2003	Ming-Tsong Wang	0941-0841P	5290

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EXAMINER
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MALDONADO, JULIO J

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 12/08/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

<b>Office Action Summary</b>	<b>Application No.</b> 10/660,573	<b>Applicant(s)</b> WANG ET AL.	
	<b>Examiner</b> Julio J. Maldonado	<b>Art Unit</b> 2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 30 November 2005.
- 2a) ☐ This action is **FINAL**.                      2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☒ Claim(s) 1,2,7-9,15,16,18,19,21-23,25,34,35 and 37-40 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1,2,7-9,15,16,18,19,21-23,25,34,35 and 37-40 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All    b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)  | 4) <input type="checkbox"/> Interview Summary (PTO-413)<br>Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)                                   | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152)             |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)<br>Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____  |

### DETAILED ACTION

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 11/30/2005 has been entered.

### ***Claim Rejections - 35 USC § 103***

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1, 2, 7-9, 15, 16, 18, 19, 21-23 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (U.S. 2002/0162736 A1) in view of Wu et al. (U.S. 2003/0022513 A1) and Seshan et al. (U.S. 6352,940 B1).

Ngo et al. (Figs.3-12) teach a related method for forming a metal damascene structure including forming a cap layer (22) on a copper layer (20), wherein the cap layer (22) is silicon nitride or silicon carbide; forming a dielectric layer (13, 14, 15) on the cap layer (22); etching the dielectric layer (13, 14, 15) and the cap layer (22) to form a damascene opening (16) and expose the copper layer (20), wherein said etching forms impurities (17, 19) such as polymeric deposits on the exposed copper layer (20), and wherein the damascene (16) opening is a via having trench; treating the exposed

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copper layer (20) using a plasma process comprising an  $\text{NH}_3$  plasma and an  $\text{N}_2$  and  $\text{H}_2$  plasma to remove the impurities (17, 19) thereon; and forming a second copper layer (53A) in the damascene opening ([0021] – [0030]).

Ngo et al. fail to teach wherein said etching uses a fluorine-containing plasma or a chlorine containing plasma and wherein said plasma further includes nitrogen and oxygen. However, Wu et al. (Figs.3A-3B) in a related method to form interconnects teaches providing a substrate (300); forming a cap layer (302) on the substrate (300); forming a dielectric layer (306) on the cap layer (302); etching the dielectric layer (306) by means of reactive ion etching using a fluorine-containing plasma recipe, wherein the plasma creates impurities on the dielectric layer (306); and providing a plasma treatment comprising a hydrogen containing gas, a nitrogen containing gas and an oxygen containing gas or mixtures thereof to remove said impurities from the dielectric layer (306) ([0021] – [0035]). Further support for using a fluorine containing plasma to form damascene structures can be found in Ali et al. to U.S. 6,605,540 B2, Figs.2a-2b and column 2, line 3 – column 3, line 4.

It would have been within the scope of one of ordinary skill in the art to combine the teachings of Ngo et al. and Wu et al. to enable the etching process of Ngo et al. to be performed according to the teachings of Wu et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching process of Ngo et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07. It would also have been obvious to one of ordinary skill in

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the art at the time the invention was made to combine the teachings of Ngo et al. and Wu et al. to enable using nitrogen gases and oxygen gases as part of the plasma treatment as taught by Wu et al. in the plasma treatment of Ngo et al. because this would facilitate the contaminant removal process in Ngo et al. (Wu et al., [0024]).

The combined teachings of Ngo et al. and Wu et al. substantially teach all aspects of the invention but fail to teach wherein said plasma further includes  $N_2O$ . However, Seshan et al. teach a method of treating a substrate surface teach treating dielectric and conductive surfaces with a plasma comprising  $N_2O$ , wherein said  $N_2O$  plasma is a well-known agent to clean surfaces from contaminants such as hydrocarbons and fluorine residues from etching processes (Seshan et al., column 6, line 34 – column 7, line 10). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of Ngo et al. and Wu et al. with Seshan et al. to enable adding  $N_2O$  as a cleaning agent in the process of Ngo et al. and Wu et al. as taught of Seshan et al., because  $N_2O$  plasma is a well-known agent to clean surfaces from contaminants such as hydrocarbons and fluorine residues from etching processes (column 7, lines 3 – 10).

4. Claims 34, 35 and 37-40 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (U.S. 2002/0162736 A1) in view of Wu et al. (U.S. 2003/0022513 A1) and Huang (U.S. 2002/0054962 A1) and Seshan et al. (U.S. 6,352,940 B1).

Ngo et al. (Figs.3-12) teach a related method for forming a metal damascene structure including forming a cap layer (22) on a copper layer (20), wherein the cap

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layer (22) is silicon nitride or silicon carbide; forming a dielectric layer (13, 14, 15) on the cap layer (22); etching the dielectric layer (13, 14, 15) and the cap layer (22) to form a damascene opening (16) and expose the copper layer (20), wherein said etching forms impurities (17, 19) such as polymeric deposits on the exposed copper layer (20), and wherein the damascene (16) opening is a via having trench; treating the exposed copper layer (20) using a plasma process comprising an  $\text{NH}_3$  plasma and an  $\text{N}_2$  and  $\text{H}_2$  plasma to remove the impurities (17, 19) thereon; and forming a second copper layer (53A) in the damascene opening ([0021] – [0030]).

Ngo et al. fail to teach wherein said etching uses a fluorine-containing plasma or a chlorine containing plasma and wherein said plasma further includes nitrogen and oxygen. However, Wu et al. (Figs.3A-3B) in a related method to form interconnects teaches providing a substrate (300); forming a cap layer (302) on the substrate (300); forming a dielectric layer (306) on the cap layer (302); etching the dielectric layer (306) by means of reactive ion etching using a fluorine-containing plasma recipe, wherein the plasma creates impurities on the dielectric layer (306); and providing a plasma treatment comprising a hydrogen containing gas, a nitrogen containing gas and an oxygen containing gas or mixtures thereof to remove said impurities from the dielectric layer (306) ([0021] – [0035]). Further support for using a fluorine containing plasma to form damascene structures can be found in Ali et al. to U.S. 6,605,540 B2, Figs.2a-2b and column 2, line 3 – column 3, line 4.

It would have been within the scope of one of ordinary skill in the art to combine the teachings of Ngo et al. and Wu et al. to enable the etching process of Ngo et al. to

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be performed according to the teachings of Wu et al. because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed etching process of Ngo et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07. It would also have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of Ngo et al. and Wu et al. to enable using nitrogen gases and oxygen gases as part of the plasma treatment as taught by Wu et al. in the plasma treatment of Ngo et al., because this would facilitate the contaminant removal process in Ngo et al. (Wu et al., [0024]).

The combined teachings of Ngo et al. and Wu et al. also teach using a resist to perform the patterning of the dielectric layer (Wu et al., [0028]), but fail to expressly teach wherein said resist contains carbon. However, Huang in a related method to form an interconnect structure teaches using organic photoresists as part of the patterning process in the formation of said interconnects (Huang, [0004]). It would have been within the scope of one of ordinary skill in the art to combine the teachings of Ngo et al. and Wu et al. with Huang to enable patterning the dielectric layer of Ngo et al. and Wu et al. according to the teachings of Huang because one of ordinary skill in the art at the time the invention was made would have been motivated to look to alternative suitable methods of performing the disclosed patterning step of Ngo et al. and Wu et al. and art recognized suitability for an intended purpose has been recognized to be motivation to combine. MPEP 2144.07.

The combined teachings of Ngo et al., Wu et al. and Huang substantially teach all aspects of the invention but fail to teach wherein said plasma further includes  $N_2O$ . However, Seshan et al. teach a method of treating a substrate surface teach treating dielectric and conductive surfaces with a plasma comprising  $N_2O$ , wherein said  $N_2O$  plasma is a well-known agent to clean surfaces from contaminants such as hydrocarbons and fluorine residues from etching processes (Seshan et al., column 6, line 34 – column 7, line 10). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the teachings of Ngo et al., Wu et al. and Huang with Seshan et al. to enable adding  $N_2O$  as a cleaning agent in the process of Ngo et al., Wu et al. and Huang as taught of Seshan et al., because  $N_2O$  plasma is a well-known agent to clean surfaces from contaminants such as hydrocarbons and fluorine residues from etching processes (column 7, lines 3 – 10).

### ***Response to Arguments***

5. Applicant's arguments filed 11/30/2005 have been fully considered but they are not persuasive.

Applicants argue, "...the  $N_2O$  plasma treatment disclosed by Seshan et al. causes micro-roughening on the surface of the oxide layer 28. It is well known in the art that micro-roughening on the interface between two materials improves the adhesion between these materials. That is, the plasma treatment is employed to provide a layer with a rough surface, rather than to clean a surface of copper or copper alloy from contaminants. Thus, there is no reason to employ an  $N_2O$  plasma in the methods disclosed by Ngo et al. and Wu et al...". In response to this argument, there is no



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teaching in the prior art of record of adverse effects of using N<sub>2</sub>O, nor any teaching that performing the cleaning process of the combined teachings of the prior art of record might cause the final product not to work.

Also, Applicants argue, "...The Examiner has asserted that Seshan et al. teaches <sup>treating</sup> ~~teaching~~ a substrate surface with an N<sub>2</sub>O plasma as a well-known agent to clean oxide surface from contaminants such as hydrocarbons and fluorine residues from etching processes. Applicants disagree...". In response to this argument, Seshan et al. teach in column 7, line 3 – 10, "...It is also well-known that nitrous oxide plasma vapor 145 also acts as a cleaning agent. Various contaminants may exist on the surface of oxide layer 28 such as hydrocarbons from the fabrication ambient and fluorine residues from metal etch. Nitrous oxide vapor plasma 145 aids in the removal of these and other contaminants prior to the deposition of a hard passivation layer on top thereof...". Furthermore, Seshan et al. teach said N<sub>2</sub>O plasma treatment on a dielectric layer surface having a metal pattern, wherein said metal pattern comprises copper.

### **Conclusion**

6. Applicants are encouraged, where appropriate, to check Patent Application Information Retrieval (PAIR) (<http://portal.uspto.gov/external/portal/pair>) which provides applicants direct secure access to their own patent application status information, as well as to general patent information publicly available.


7. Any inquiry concerning this communication or earlier communications from the examiner should be directed to examiner Julio J. Maldonado whose telephone number is (571) 272-1864. The examiner can normally be reached on Monday through Friday.

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8. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith, can be reached on (571) 272-1907. The fax number for this group is 571-273-8300. Updates can be found at <http://www.uspto.gov/web/info/2800.htm>.

Julio J. Maldonado  
Patent Examiner  
Art Unit 2823

Julio J. Maldonado  
December 6, 2005



George Fourson  
Primary Examiner